The twelve cranial nerves of Christmas: mnemonics, rhyme, and anatomy - seeing the lighter side

Article (Accepted Version)

ASE-18-0214.R1

Viewpoint Commentary

The Twelve Cranial Nerves of Christmas:

Mnemonics, rhyme, and anatomy - seeing the lighter side.

Claire F. Smith[1,*], Scott Border[2]

[1]Department of Medical Education, Brighton and Sussex Medical School, University of Sussex, Brighton, United Kingdom

[2]Centre for Learning Anatomical Sciences, University of Southampton, Southampton, United Kingdom

Running title: Mnemonics in anatomy

*Correspondence to: Dr. Claire F. Smith, Brighton and Sussex Medical School, University of Sussex, Medical School Building, Falmer, BN1 9PX, United Kingdom. E-mail: c.smith@bsms.ac.uk

ABSTRACT

Anatomy, has in history, been linked to helpful ways to remember structures, branches of nerves, structures passing through foramina et cetera. Scalp is even a mnemonic in itself (Skin, Connective tissue, Aponeurosis, Loose areolar tissue, Pericranium). There has been concern by some educators that using mnemonics or rhymes promotes a surface approach to learning and is unhelpful in establishing long term and meaningful deep learning. This article argues that mnemonics and rhyme can be used, in the appropriate way, at the right time, by students as an important learning strategy. That strategy can help lay a foundation of knowledge to be developed and later built upon, or simply recall information more easily. Mnemonics, like all information that is to be recalled, is consolidated by rehearsal. In examining the neuroanatomy of learning theories, it is therefore possible to suggest that when students begin to learn an area of anatomy, such as the cranial nerves, using a mnemonic or rhyme can help students remember the names and facilitate engagement of working memory processes assisting the student to build a construct for subsequent deeper layers of knowledge. Modern approaches to anatomy education involve a myriad of learning opportunities, but educators must assess the value of each one before recommending them to students. It appears that using mnemonics and rhyme is as valid today as it has been for centuries.

Keywords: gross anatomy education, mnemonics, memory, retrieval practice, core syllabus, cranial nerves, learning, rhyme.

INTRODUCTION

It is fall and time to give three lectures that cover the anatomy and function of the cranial nerves and the associated anatomy of the head and neck. The content is aligned to the Anatomical Society core regional anatomy syllabus, of course (Smith et al., 2016) and the slides are perfected from four years of iterations. Last year's version of the lecture is still sitting in the virtual learning environment for everyone to see, should they wish – not that they will, which is a blessing, since it means you can probably get away with telling the same jokes again this year. The following week, students visit the dissecting room working in small groups and remove the brain from their cadaver to examine the cranial nerves for themselves – exciting stuff. Students will also experience medicine in practice sessions and learn how to perform a cranial nerve examination on a patient. So, although everything appears to be in order, what everyone is really waiting for is the obligatory choir-esque rendition of '*The Twelve Cranial Nerves of Christmas*' (Hope, 2012; Smith, 2017c), a parody song invented by either students or anatomists, who probably had far too much time on their hands.

Ingrained in medical school folk law, the cranial nerve song has been passed down through generations of anatomists and medical students much like the mnemonic for remembering the names of all the cranial nerves. If you are not familiar with the 'Twelve Cranial Nerves of Christmas', don't worry, just hum to the melody of a carol composed and published by Frederic Austin in 1909, '*The Twelve Days of Christmas'* and add in: 'The first cranial nerve is the olfactory nerve, and it has a funny kind of smell', (action - sniff sniff). In this version the classic 'Five gold rings chant' is replaced with the roar of 'neu-ral-gia' or 'tri-gem-inal' or 'mast-i-cation'

depending on the version you are working to. The last round being 'Twelve- stick your tongue out, eleven- shrug your shoulders, ten- makes you sick, nine- very tasty, eight- makes you dizzy, seven- funny faces, six- sideways glances, five- mast-i-cation, four- down and out, three- up and down, two- helps you see and the first has a funny kind of smell'. If you would like to get more animated, the cranial nerve mime has actions for every component (Dickenson and Stephens, 2015). If you are not feeling the festive spirit or it is spring when you teach this, then different versions have been created to accompany the melody of other songs, for example: "*Somewhere Over the Rainbow*" (a medley of the songs "Over the Rainbow" and "What a Wonderful World" recorded by a Native Hawaiian singer Israel Kamakawiwoʻole in his 1990 album *Ka ʻAnoʻi*), and the much more contemporary "*Call Me Maybe,*" song recorded by a Canadian singer Carly Rae Jepsen in her 2012 album *Kiss.* But apart from being a bit of fun and making students smile, how is this helping them to learn? It is likely that the way in which the sequential information is being presented is helping students to remember the order (Tulving and Craik, 2000) of cranial nerves as well as the actions of the nerves.

The order of how information is presented is an important trait of mnemonics which are also used by students studying anatomy. The example of the cranial nerves is a classic; twelve nerves, in a set order, that any medical or allied health care student has to master. The mnemonics for the cranial nerves are numerous (several of them are far too inappropriate to print). Therefore, we will go with - 'On On On They Travelled And Found Voldemort Guarding Very Ancient Horcruxes' or the other clean one which springs to mind, 'Oh Oh Oh To Touch And Feel Very Good Velvet, such Heaven!'. Many more examples of mnemonics can be found at

mnemonics websites (e,g., Wiese, 2018). Mnemonics are often used when the amount of information presented challenges our working memory (Miller 1956; Baddeley, 1986) and their use has been shown to enhance learning (Bellezza, 1981). It is therefore not surprising that to help recall these twelve nerves, such aide-memoires were sought.

So, apart from helping with the festive spirit where is all this going you may ask? Well, due to lots of determined effort over the past 20 years', medical curricula have been reformed. They are now fully integrated, aligned and offer lots of flexible learning opportunities (Drake et al., 2009). Anatomy has long been the corner stone of medical practice (Davis et al., 2014), but students continue to struggle with learning anatomy because it is an information rich subject. The authors therefore ask if the spirit of mnemonics and rhyme either help or hinder learning of the subject for the students?

LEARNING PROCESSES AND MNEMONICS

Mnemonics are, essentially a learning tool that can be used as a strategy in the earliest stages of learning and memory because they assist in two major aspects of memory processing. Firstly, they enable the serial order or sequence of information to be remembered. Secondly, they rely on a well-established memory technique in psychology known as 'chunking' (Tulving and Craik, 2000). This term refers to the process of taking individual pieces of information (chunks) and grouping them into larger units. By grouping each piece into a large whole, you can improve the amount of information you can remember.

This is useful for learning all the names of cranial nerves because there are twelve of them - a number which more than challenges the limits of human short-term memory processing according to the classic models, (Miller 1956; Baddeley, 1986). Theories of working memory suggest that school children are frequently taught many mnemonics as a learning aid- especially with spelling; for example, spelling the word 'because'- Big Elephants Can Always Understand Small Elephants'. The principle behind using mnemonics is to connect information that can be learned with key letters. This 'key word/letter' method was established in undergraduate education and then later applied to school children (Mastropieri, 1989). This is a short-term process which briefly preserves the information in sensory memory. It provides cues to enable longer-term processing, allowing for repetition or rehearsal of the information. The interesting aspect of rehearsal is that it is a skill acquired through training, and not inherently adopted as a technique in young children (Zelinsky and Murphy, 2000).

LEARNING PROCESSES AND RHYME

Using rhyme or song as a tool in learning can be helpful in a number of ways. It may be similar to a mnemonic and prompt the recognition of a serial order. Young school children still adopt the rhyme '*1,2,3,4,5, once I caught a fish alive*' to help them count up to ten. Nursery rhymes are used as an early form of learning strategy to help teach phonics and to foster imagination in children (Raquette and Rieg, 2008). Rhymes are thought to involve less effort to learn which would suggest the learning process is an unconscious one (Raquette and Rieg, 2008). Very similar to mnemonics, rhymes utilize repetition or rehearsal of information to help consolidate the information into more stable, longer term processing (Zelinsky and Murphy, 2000). The

widely popular '*Twinkle Twinkle Little Star'* nursery rhyme (first published in London in 1806 in *Rhymes for the Nursery* by Ann and Jane Taylor; Opie and Opie, 1997) provides an easy to copy song that can help students see how words rhyme e.g., are and star (Paquette and Rieg, 2008). A key to rhymes or songs that may aid learning is the short and playful story they provide.

ANATOMICAL KNOWLEDGE, MNEMONICS AND RHYME

Anatomical knowledge can be divided into propositional knowledge and non-technical knowledge (Klein, 1971), and the use of mnemonics and rhyme can cover both. An example of propositional knowledge as a mnemonic might be, for example, 'Say Grace Before Tea', (sartorius, gracillis, and semitendinosus) as the order in which muscles insert onto the tibia. To compare, an example of non-technical knowledge might be 'ABCDE' (airway, breathing, circulation, disability, exposure) approach for the stages of urgent patient management. An example of a rhyme might be '*C,3,4 and 5 keeps the diaphragm alive'* or '*S,2,3,4 keeps poo off the floor*'. Both of these mnemonics and rhymes offer a crucial reminder framework, and it is this framework that may be helpful in learning anatomy. There is a cognitive difference between remembering and knowing (Moscovitch, 1992). Evidence suggests repetition over time can build a network that represents knowledge (Nadel and Moscovitch, 1997). In pedagogical terms the use of mnemonics has previously been criticized for promoting a surface approach to learning anatomy (Smith and Mathias, 2010; Ward, 2011; Lewis, Mulligan and Kraus, 2018). However, the idea of using mnemonics or rhymes as cues to call up knowledge in healthcare professional education supports the notion that they can be used by students for anatomy as a framework to build upon their knowledge and understanding. (Pinkofsky, 1997;

Pinkofsky and Reeves, 1998; Dyson et al., 2004; Gravel et al., 2010; Rubakovic and Steffen, 2011; Carnegie, 2012; Meyer et al., 2015; Smith et al., 2017a)

NEUROANATOMY OF MNEMONICS AND RHYME

Memory is the term that describes the processes and structures involved in the storage and retrieval of information. The rehearsal of knowledge is an important stage in learning since, ultimately it is a way of holding information in short term memory, in the hope that it can be encoded into long term memory eventually (Miller, 1956). Hence, the idea that repeating whimsical phrases or songs can assist in embedding memories to eventually make them more stable (Alvarez and Squire, 1994). Evidence from 23 memory athletes has revealed that the functional connectivity of the brain can change as a direct result of mnemonic training (Dresler et al., 2017).

Rehearsal of knowledge is processed as working memory and involves neurons in the inferior temporal cortex (Sigala, 2009) that serve to store visual long-term memory (Tomita et al., 1999); however, it is always a verbal process regardless of how the original information was presented (McLeod, 2013). Visual working memory helps to create a temporary memory, but for that memory to remain permanently, it must be reinforced. Existing evidence suggests that continued retrieval of anatomy knowledge positively affects learning (Feigin et al., 2007; Larsen et al., 2013; Meyer et al., 2015). The use of mnemonics could help students to lay down initial understanding that they can later expand upon. So even a simple song or ditty, or limerick as described by Carnegie (2013), or just listing the order of nerves can help a student to build

knowledge at the higher levels of taxonomy (Bloom, 1956). It is likely that for students learning anatomy for the first time, the use of mnemonics becomes useful for retrieval at the early stages of learning. Retrieval is important because it shows us what has been learnt (Nunes and Karpicke, 2015).

Human brains are not efficient at handling excessive amounts of new information at one time, so overworking memory could hinder learning for our students (Chan and Cheng, 2011). Therefore, although the sequential processing of recalling information using a mnemonic may in itself be considered somewhat superficial, if this reduces cognitive load later on it may lead to longer term memory storage eventually. Karpicke and Smith (2012), demonstrated that repeated retrieval using mnemonics enhanced long term retention. Behavioral studies have shown that with long retention intervals working memory requires an effortful first stage, but with practice, this is followed by an automated less effortful second stage (Aldridge et al., 1987; Phaf and Wolter, 1993). This would suggest that mnemonics or rhyme has the potential to be particularly valuable during the early stage of short retention intervals, as a way to reduce the effortful first rehearsal experience (Rowland and DeLosh, 2015).

It is very likely that subsequent recall in the future will not require use of the mnemonic or rhyme because long term memories are retrieved by an association process and not via sequential recall (McLeod, 2013). If this learning path eventually leads to a higher level of understanding, such as the type of information the nerve conveys, or how the nerve can be clinically tested, then the use of the mnemonic will have served a useful purpose. Furthermore,

it is also understood that students learn better when they are actively engaged in an immersive learning experience, such as when singing a song or undertaking a mime (Biggs, 1999; Vasan and DeFouw, 2005; Dickson and Stephens, 2015).

Active engagement in learning may force our working memories to utilize multimodal stimuli involving consistent dialogue between our pre-frontal lobes and large regions of the neocortex (Smith et al., 2017b). The end result is the shortened lines of reasoning, the encapsulation of knowledge (Boshuizen et al., 1995). This means that the knowledge becomes restructured and students can move quickly and fluently between using the knowledge and understanding the fundamental principles. For example, in being able to clinically test the function of the superior oblique muscle without having to think about the direction of pull and the effect the trochlea has on tendon insertion into the globe of the eye.

Later on, during training or even after qualification, longer term recall can be aided by a mnemonic; a newly qualified doctor moving to a new rotation might have to quickly remember the anatomy of the orbit. Doctors knows that the superior orbital fissure permits lots of nerves and vessels, but they are unsure of the precise detail. In these circumstances using a mnemonic 'live free to see no insult at all' (other inappropriate versions are available!) for the structures starting with the letters LFTSNIA (lacrimal nerve, frontal nerve, trochlear nerve, superior branch of oculomotor nerve, nasocillary nerve, inferior branch of oculomotor nerve, abducens nerve) will enable factual recall. The neuroanatomy of this can be explained by the metacognitive processes of memory retrieval since this relies upon accessing cues or reminders from

consciousness (Mazzoni and Kirsch, 2002). The more representations of the learning/memory that exist the greater likelihood of successful retrieval. This can be further enhanced with feedback provided at the time of retrieval (Agarwal et al., 2017). Therefore, mnemonics or rhymes that capitalize on these aspects can potentially aid in the learning process.

The authors are not saying that mnemonics or rhymes provide the only strategy. Other strategies can come from internal aids such as mental rehearsal or external aids such as asking someone else. It has been suggested that external aids assist in the encoding and retrieval of knowledge, (Intons-Peterson and Fournier, 1968). Evidence suggests that the use of drawings increases memory of science information (Pals et al., 2018). The use of drawing and anatomy have been intrinsically linked for centuries, and it is suggested this use promotes haptic reasoning and visuospatial ability (Balemans et al.; Backhouse et al.; Keenan et al., 2017). Indeed, a prescribed way to remember a series of items is to use 'memory snapshots' of visual items that are vivid and symbolic (Bower, 1970).

CONCLUSION

So, where does this leave our *Twelve Cranial Nerves of Christmas* parody song? - is this and the mnemonic just as relevant today as it was to medical students 20-30-40 years ago – does it still have a place amongst all the technological advances in anatomy education? In our opinion the answer is 'yes' because the concept of learning what a cranial nerve is has always remained the same. In our view, as long as the use of a rhyme or mnemonic opens the door to deeper learning, through the aid of cognitive cues (Bellezza, 1981) then it has served the student well.

It is important to remember that retrieval does not only occur during assessment (Nunes and Karpicke, 2015). In clinical settings there is likely to be a wide range of factors that prompt students to remember a certain piece of information. It may be that the use of a mnemonic has assisted this. Educators may understand more about how students learn and about how doctors apply knowledge in clinical practice (Boshuizen et al., 1995) but at a base line there is still a body (pun intended), of information to gain. Despite the myriad of eLearning and mobile applications to support learning, a good old-fashioned sing along, rude or otherwise, can sometimes be just what the doctor ordered, to keep learning fun and manageable!

NOTES ON CONTRIBUTORS:

CLAIRE F. SMITH, B.Sc., P.G.C.E., Ph.D., S.F.H.E.A., F.A.S., F.L.F., N.T.F. is Head of Anatomy at Brighton and Sussex Medical School (Brighton), Falmer, United Kingdom. She is a fellow of the Anatomical Society, a member of the Court of Examiners for the Royal College of Surgeons England and Secretary General for the European Federation of Experimental Morphologists. She teaches all areas of gross anatomy and her research is in understanding the learning experience.

SCOTT BORDER, B.Sc., (Hons.), Ph.D., F.A.S., F.H.E.A., is a principal teaching fellow in anatomy in the Centre for Learning Anatomical Sciences and Deputy Head of Medical Education at University of Southampton, Southampton, UK. He is subject lead for neuroanatomy and his research interests are in medical education, neuroanatomy, peer-teaching and learning technologies.

LITERATURE CITED

Agarwal PK, Finley JR, Rose NS, Roediger HL 3rd. 2017. Benefits from retrieval practice are greater for students with lower working memory capacity. Memory 25:764–771.

Aldridge JW, Garcia HR, Mena G. 1987. Habituation as a necessary condition for maintenance rehearsal. J Mem Lang 26:632–637.

Alvarez P, Squire LR. 1994. Memory consolidation and the medial temporal lobe: A simple network model. Proc Natl Acad Sci U S A 91:7041–7045.

Backhouse M, Fitzpatrick M, Hutchinson J, Thandi CS, Keenan ID. 2017. Improvements in anatomy knowledge when utilizing a novel cyclical "Observe-Reflect-Draw-Edit-Repeat" learning process. Anat Sci Educ 10:7–22.

Baddeley AD. 1987. Working Memory. 1st Ed. Oxford, UK: Oxford University Press. 304 p.

Bellezza FS. 1981. Mnemonic devices: Classification, characteristics, and criteria. Rev Educ Res 51:247–275.

Balemans MC, Kooloos JG, Donders AR, Van der Zee CE. 2016. Actual drawing of histological images improves knowledge retention. Anat Sci Educ 9:60–70.

Biggs J. 1999. What the student does: Teaching for enhanced learning. High Educ Res Dev 18:57–75.

Bloom BS (Editor). 1956. Taxonomy of Educational Objectives, Handbook I: Cognitive Domain. 1st Ed. New York, NY: David McKay Co. 201 p.

Boshuizen HP, Schmidt HG, Custers EJ, Van De Wiel MW. 1995. Knowledge development and restructuring in the domain of medicine: The role of theory and practice. Learn Instr 5:269–289.

Bower GH. 1970. Analysis of a mnemonic device: Modern psychology uncovers the powerful components of an ancient system for improving memory. Am Sci 58:496–510.

Carnegie JA. 2012. The use of limericks to engage student interest and promote active learning in an undergraduate course in functional anatomy. Anat Sci Educ 5:90–97.

Chan LK, Cheng MM. 2011. An analysis of the educational value of low-fidelity anatomy models as external representations. Anat Sci Educ 4:256–263.

Davis CR, Bates AS, Ellis H, Roberts AM. 2014. Human anatomy: Let the students tell us how to teach. Anat Sci Educ 7:262–272.

Dickson KA, Stephens BW. 2015. It's all in mime: Actions speak louder than words when teaching the cranial nerves. Anat Sci Educ 8:584–592.

Drake RL, McBride J, Lachman N, Pawlina W. 2009. Medical education in the anatomical sciences: The winds of change continue to blow. Anat Sci Educ 2:253–259.

Dresler M, Shirer WR, Konrad BN, Müller NC, Wagner IC, Fernández G, Czisch M, Greicius MD. 2017. Mnemonic training reshapes brain networks to support superior memory. Neuron 93:1227–1235.

Dyson E, Voisey S, Hughes S, Higgins B, McQuillan PJ. 2004. Educational psychology in medical learning: A randomised controlled trial of two aide memoires for the recall of causes of electromechanical dissociation. Emerg Med J 21:457–460.

Feigin DS, Magid D, Smirniotopoulos JG, Carbognin SJ. 2007. Learning and retaining normal radiographic chest anatomy: Does preclinical exposure improve student performance? Acad Radiol 14:1137–1142.

Gravel J, Roy M, Carriere B. 2010. 44-55-66PM, a mnemonic that improves retention of the Ottawa ankle and foot rules: A randomized controlled trial. Acad Emerg Med 17:859–864.

Hope T. 2012. The Twelve Cranial Nerves of Christmas. University of Nottingham Medical School, Nottingham, UK. YouTube Video 3:44 min. URL: https://www.youtube.com/watch?v=PcQyJR4dGxc&t=114s [accessed 8 November 2018].

Intons-Peterson MJ, Fournier J. 1986. External and internal memory aids: When and how often do we use them? J Exp Psychol Gen 115:267–280.

Karpicke JD, Smith MA. 2012. Separate mnemonic effects of retrieval practice and elaborative encoding. J Mem Lang 67:17–29.

Keenan ID, Hutchinson J, Bell K. 2017. Twelve tips for implementing artistic learning approaches in anatomy education. MedEdPublish 6:44.

Klein PD. 1971. A proposed definition of propositional knowledge. J Philos 68:471–482.

Larsen DP, Butler AC, Lawson AL, Roediger HI 3rd. 2013. The importance of seeing the patient: Test-enhanced learning with standardized patients and written tests improves clinical application of knowledge. Adv Health Sci Educ Theory Pract 18:409–452.

Lewis JB Jr, Mulligan R, Kraus N. 2018. The importance of medical mnemonics in medicine. Pharos 2018:30–35.

Mastropieri MA, Scruggs TE. 1989. Constructing more meaningful relationships: Mnemonic instruction for special populations. Educ Psychol Rev 1:83–111.

Mazzoni G, Kirsch I. 2002. Autobiographical memories and beliefs: A preliminary metacognitive model. In: Perfect TJ, Schwartz BL (Editors). Applied Metacognition. 1st Ed. Cambridge, UK: Cambridge University Press. p 121–145.

McLeod SA. 2013. Stages of memory-encoding storage and retrieval. SimplyPsychology: Study Guide for Psychology Students. Division of Neuroscience and Experimental Psychology, The University of Manchester, Manchester, UK. URL: https://www.simplypsychology.org/memory.html [accessed 10 October 2018].

Meyer AJ, Armson A, Losco CD, Losco B, Walker BF. 2015. Factors influencing student performance on the carpal bones test as a preliminary evaluation of anatomical knowledge retention. Anat Sci Educ 8:133–139.

Miller GA. 1956. The magical number seven, plus or minus two: Some limits on our capacity for processing information. Psychol Rev 63:81–97.

Moscovitch M. 1992. Memory and working with memory: A component process model based on modules and central systems. J Cogn Neurosci 4:257–267.

Nadel L, Moscovitch M. 1997. Memory consolidation, retrograde amnesia and the hippocampal complex. Curr Opin Neurobiol 7:217–227.

Nunes LD, Karpicke JD. 2015. Retrieval-based learning: Research at the interface between cognitive science and education. In: Scott RA, Kosslyn SM (Editors). Emerging Trends in the Social and Behavioral Sciences: An Interdisciplinary, Searchable, and Linkable Resource. 1st Ed. Hoboken, NJ: John Wiley & Sons p 1–6.

Opie I, Opie P (Editors). 1997. The Oxford Dictionary of Nursery Rhymes. 2nd Ed. Oxford, UK: Oxford University Press. 559 p.

Pals FF, Tolboom JL, Suhre CJ, van Geert PL. 2018. Memorisation methods in science education: Tactics to improve the teaching and learning practice. Int J Sci Educ 40:227–241.

Paquette KR, Rieg SA. 2008. Using music to support the literacy development of young English language learners. Early Childhood Educ J 35:227-–232.

Phaf RH, Wolters G. 1993. Attentional shifts in maintenance rehearsal. Am J. Psychol 106:353–382.

Pinkofsky HB. 1997. Mnemonics for DSM-IV personality disorders. Psychiatr Serv 48:1197–1198.

Pinkofsky HB, Reeves RR. 1998. Mnemonics for DSM-IV substance-related disorders. Gen Hosp Psychiatr 20:368–370.

Rowland CA, DeLosh EL. 2015. Mnemonic benefits of retrieval practice at short retention intervals. Memory 23:403–419.

Rubakovic S, Steffen C. 2011. Mnemonics in dermatology. Clin Dermatol 29:523–530.

Sigala N. 2009. Visual working memory and delay activity in highly selective neurons in the inferior temporal cortex. Front Syst Neurosci 3:11.

Smith CF, Finn GM, Stewart J, Atkinson MA, Davies DC, Dyball R, Morris J, Ockleford C, Parkin I, Standring S, Whiten S, Wilton J, McHanwell S. 2016. The Anatomical Society core regional anatomy syllabus for undergraduate medicine. J Anat 228:15–23.

Smith CF, Mathias HS. 2010. Medical students' approaches to learning anatomy: Students' experiences and relations to the learning environment. Clin Anat 23:106–114.

Smith CF, Tollemache N, Covill D, Johnston M. 2017a. Take away body parts! An investigation into the use of 3D-printed anatomical models in undergraduate anatomy education. Anat Sci Educ 11:44–53.

Smith CF, Finn GM, Border S. 2017b. Learning clinical anatomy. Eur J Anat 21:269–278.

Smith CF. 2017c. The Twelve Cranial Nerves of Christmas. University of Sussex, Brighton, UK. YouTube Video 3:44 min. URL: https://www.youtube.com/watch?v=hXURpwku2rk [accessed 8 November 2018].

Tomita H, Ohbayashi M, Nakahara K, Hasegawa I, Miyashita Y. 1999. Top-down signal from prefrontal cortex in executive control of memory retrieval. Nature 401:699–703.

Tulving E, Craik FI (Editors). 2000. The Oxford Handbook of Memory. New York, NY: Oxford University Press. 720 p.

Vasan NS, DeFouw D. 2005. Team learning in a medical gross anatomy course. Med Educ 39:524.

Ward PJ. 2011. First year medical students' approaches to study and their outcomes in a gross anatomy course. Clin Anat 24:120–127.

Wiese P. 2018. Mnemonic Devices; Learn Easily, Remember Forever. Mnemonic Device Est., Groningen, The Netherlands. URL: https://www.mnemonic-device.com [accessed 22 November 2018].

Zelinsky G J, Murphy GL. 2000. Synchronizing visual and language processing: An effect of object name length on eye movements. Psychol Sci 11:125–131.